FIG. 1A

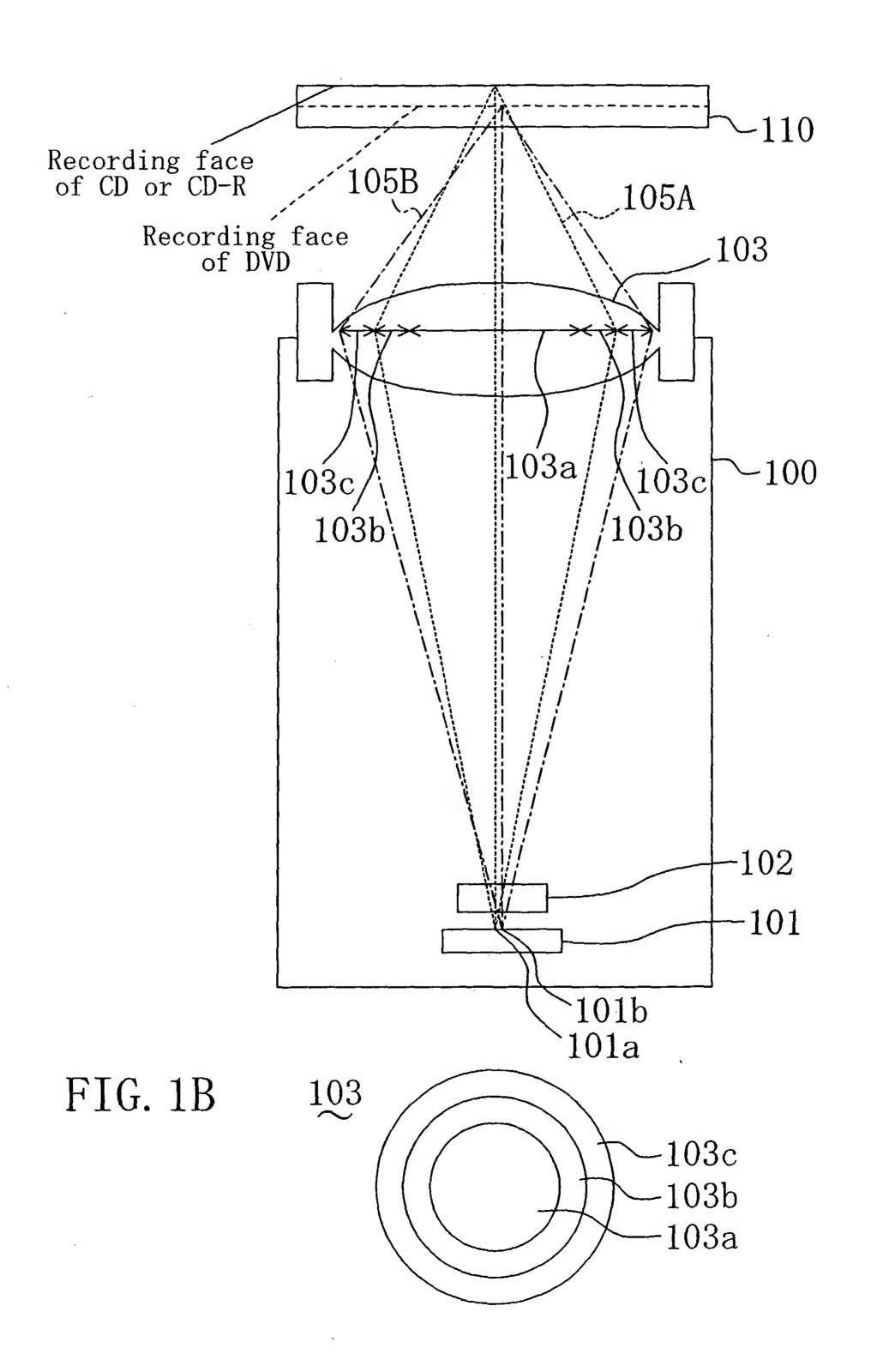


FIG. 2A

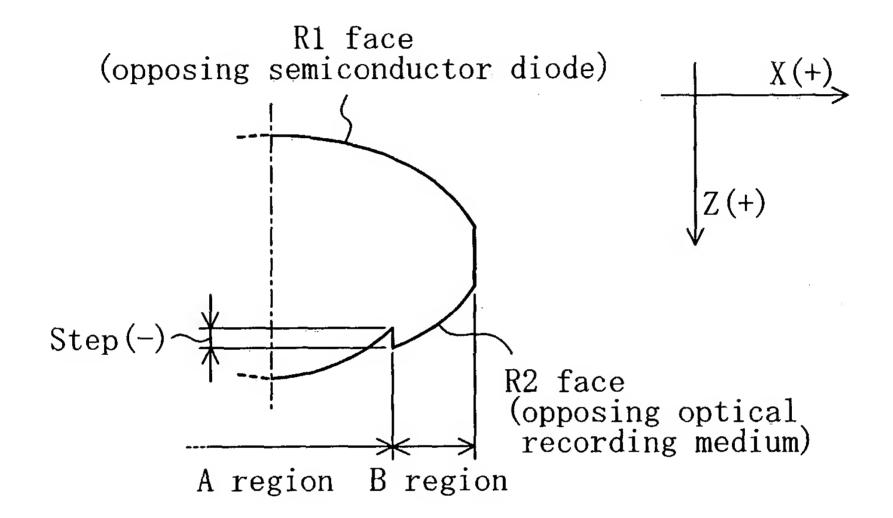
| | | | | QW |
|------------------------------|-----|------------------|------------------|------|
| tive r R2 ϕ | CD | 1.79 | 1.83 | T |
| Effective diameter R2φ | DVD | 2.69 | 2.72 | CT |
| tive r R1 φ | CD | 2.24 | 2.41 | Q |
| Effective diameter R1 ϕ | DVD | 3, 05 | 3.26 | (10) |
| ength | CD | 2.116 | 2, 319 | |
| Focal length | DVD | 2. 103 | 2.307 | TT |
| | | Design example 1 | Design example 2 | |

0.939 0.938 8 300 300 DVD 2.159 570 159 570 DVD si 254 358 16. 15. 254 358 DVD 16. 15 963 18.963 20.657 724 20.418 DVD 18. Design example Design example

WD 103 00 -102 2.8 0.685 101a, 101b

FIG. 2B

FIG. 3



| | • |
|---|---|
| | 7 |
| | |
| 1 | T |
| • | |

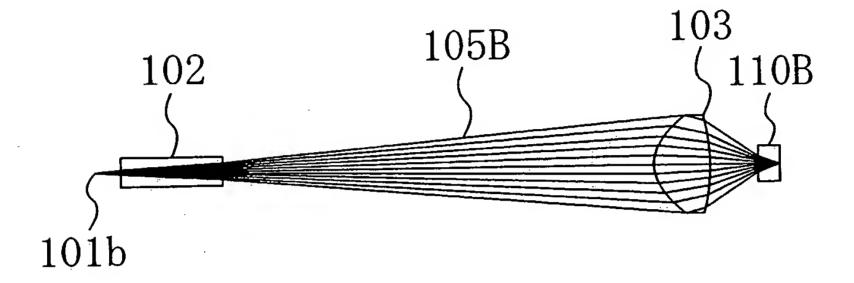
| | | | | | | | | | | |
|---|--------------------|-----------------------|---|-------------------|-----------|----------------------------|-------------------------------|----------------------------|--------------------------|-----------|
| Region for DVD | R2 face (B region) | | 2.692 | - 2.79098 | 0.00000 | $7.06736E \times 10^{-2}$ | -1 .35424E $\times 10^{-2}$ | $1.42971E \times 10^{-3}$ | $0.00000E \times 10^{0}$ | 0.001481 |
| Region for CD (partly including region for DVD) | R2 face (A region) | | 1.787 | - 2.81207 | 0.00000 | 6.57018E ×10 ⁻² | - 1.33152E ×10 ⁻² | 2.43982E ×10 ⁻³ | 0.00000E×10 ⁰ | 0.0 |
| Region for DVD and CD | R1 face | 1.57026 | 3.050 | 1.47929 | - 1.24492 | 1.91049E ×10 ⁻² | 2.92900E ×10 ⁻³ | 3.53749E ×10 ⁻⁴ | 0.00000E×10 ⁰ | |
| | | Center thickness (mm) | Effective (region) diameter (ϕ) (mm) | Curvature(R) (mm) | K | A 4 | A 6 | . A 8 | A 10 | Step (mm) |

2.714 $\times 10^{-2}$ $\times 10^{-2}$ $1.85528E \times 10^{-3}$ 0.00000 2.38194 $0.000000\mathrm{E}\!\times\!10^{0}$ (B region) Region for DVD 5.95038E 1.26669E R2 face 0.001422 1.826 $\times 10^{-2}$ $\times 10^{-2}$ Region for CD (partly including region for DVD) $3.34402E \times 10^{-3}$ 0.00000 2.39375 $0.00000\mathrm{E}\!\times\!10^{0}$ face (A region) 5.58818E 1.36935E **R**2 3.252 1.7036 $\times 10^{-4}$ $2.76338E \times 10^{-4}$ $7.16899E \times 10^{-3}$ $0.000000\mathrm{E}\!\times\!10^{\mathrm{o}}$ 2.159346 1.272987 Region for DVD and CD 5.24988E face R1(mm) (ϕ) Center thickness (mm) Effective (region) diameter Curvature (R) (mm) Step(mm) A 10 A 8 9 \succeq ď A

FIG. 5

FIG. 6A

Design example 1: Optical path for DVD



 $2.50 \, \text{mm}$

FIG. 6B

Design example 1: Optical path for CD

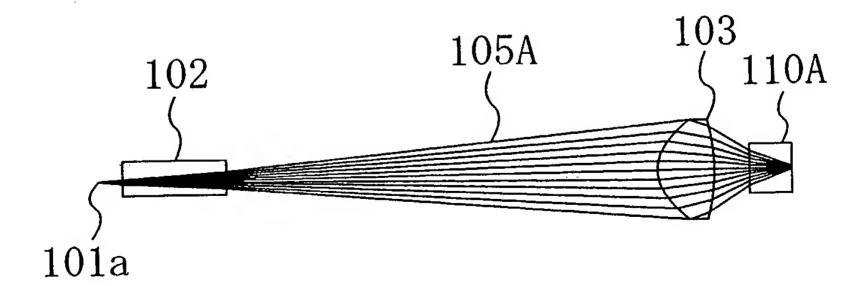
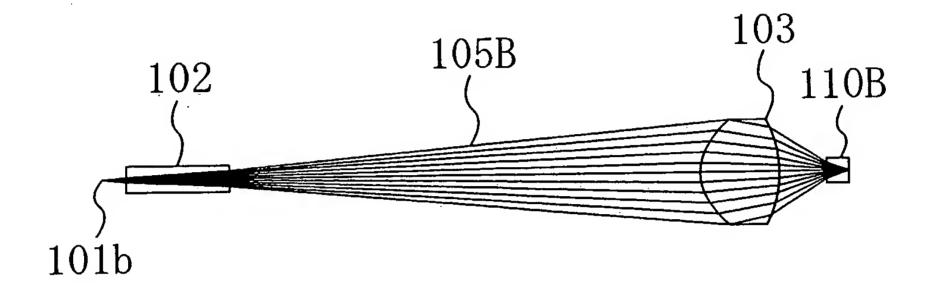


FIG. 7A

Design example 2: Optical path for DVD



2.50mm

FIG. 7B

Design example 2: Optical path for CD

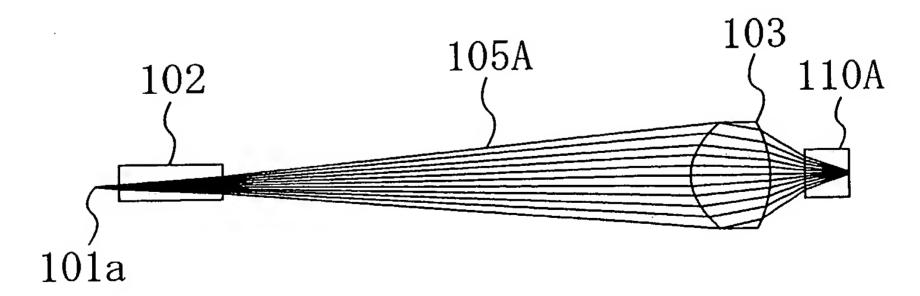


FIG. 8

| | Opt magnif | ical ication |
|------------------|---------------|-----------------|
| | DVD | CD |
| Design example 1 | - 0. 167 | - 0. 168 |
| Design example 2 | - 0. 167 | - 0. 168 |

FIG. 9A

Design example 1: For DVD

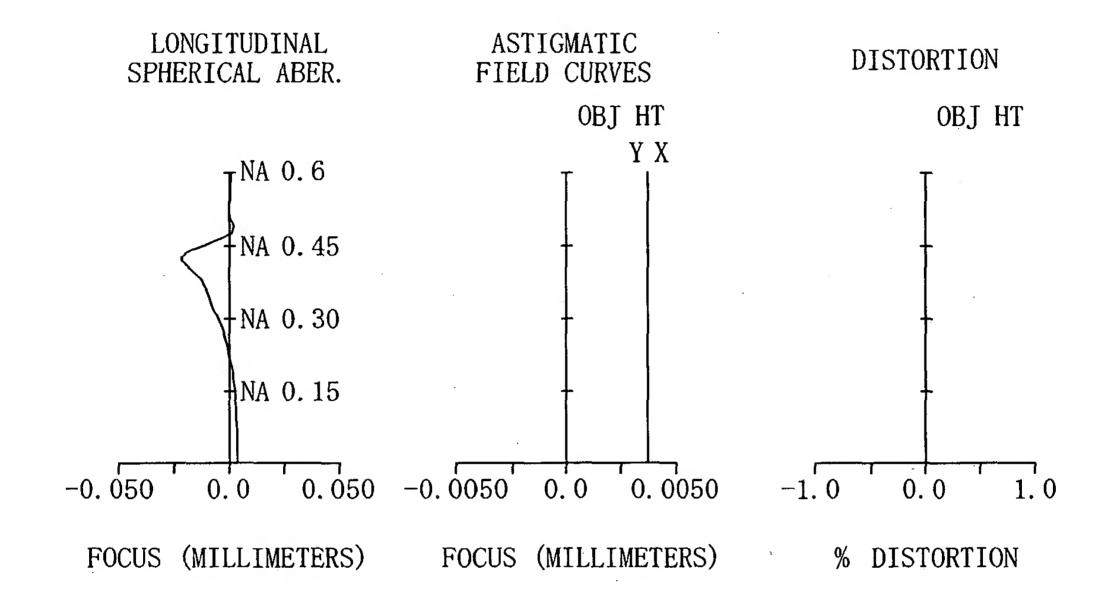


FIG. 9B

Design example 1: For CD (numerical aperture not limited)

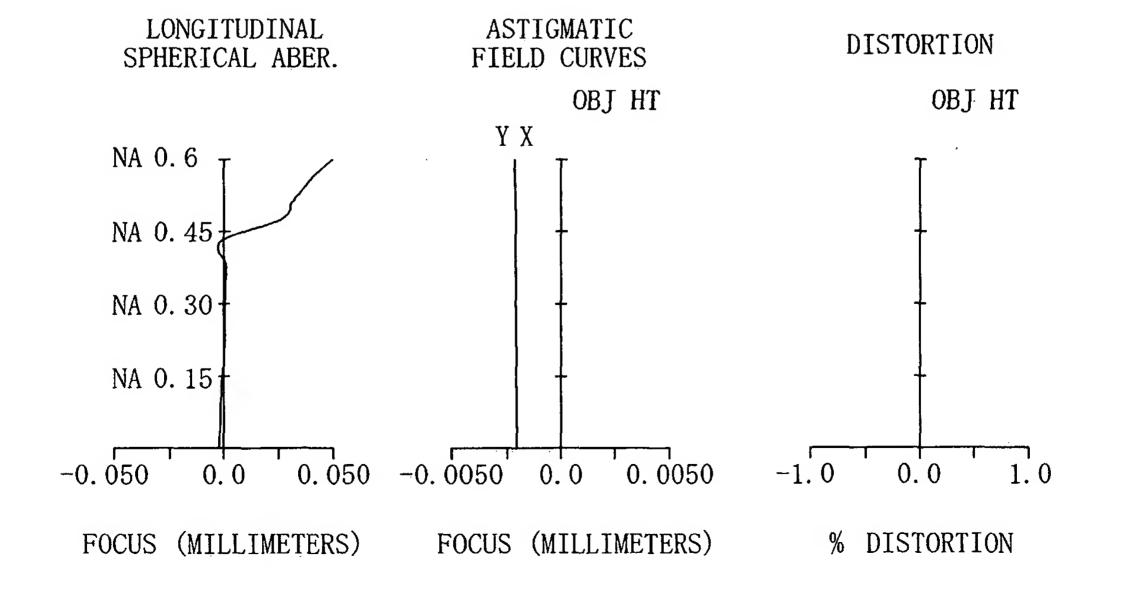


FIG. 10A

Design example 2: For DVD

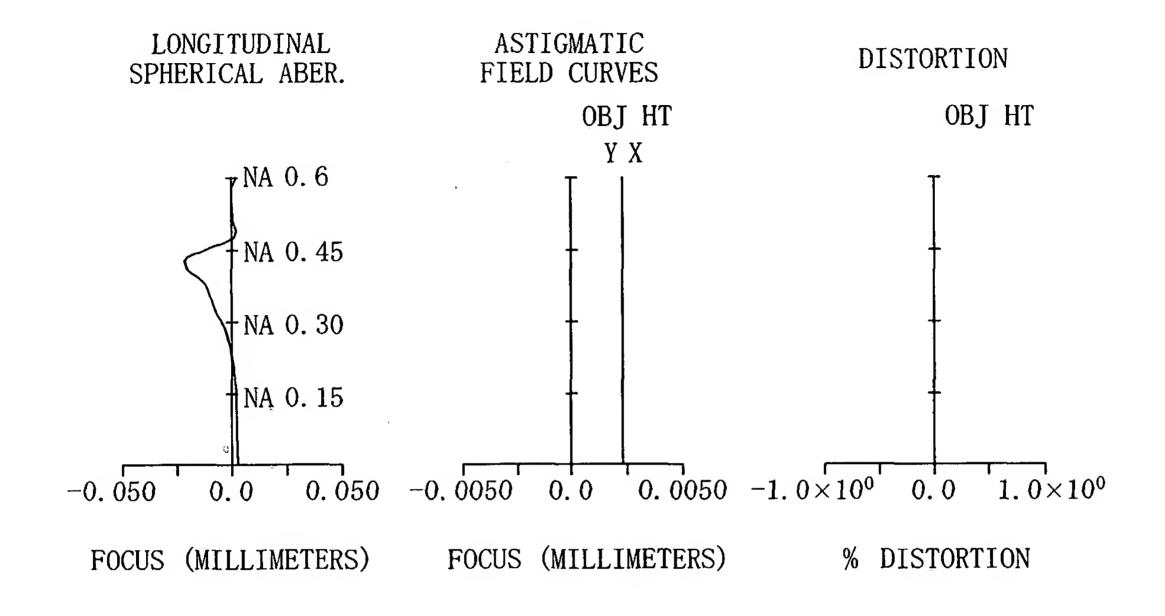
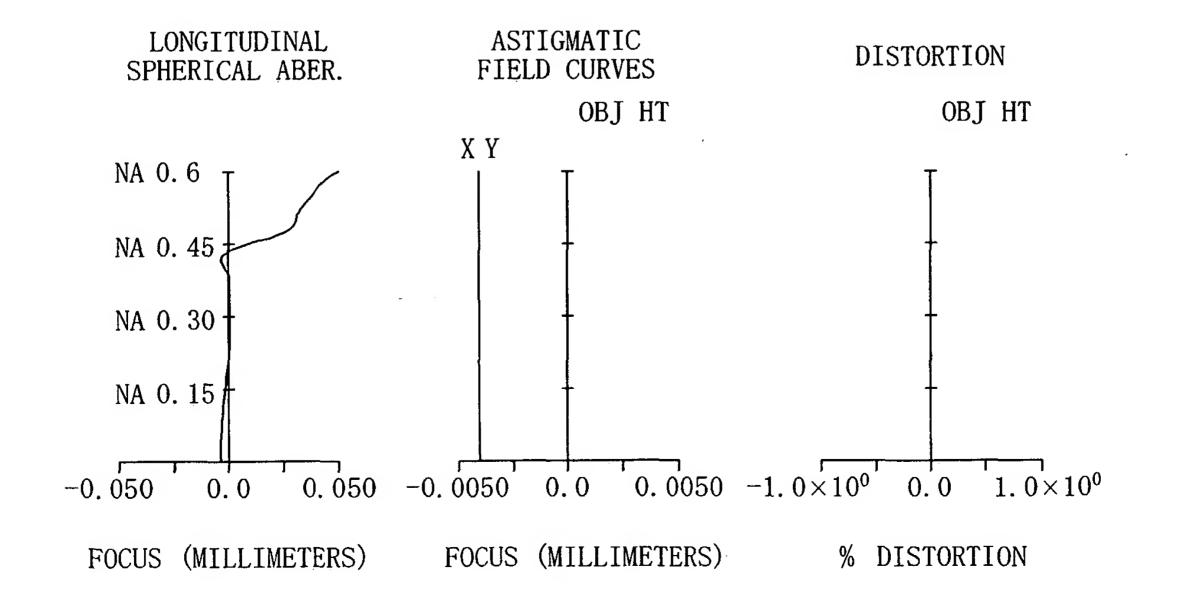


FIG. 10B

Design example 2: For CD (numerical aperture not limited)



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FIG. 11A

Design example 1: Point image intensity distribution in DVD

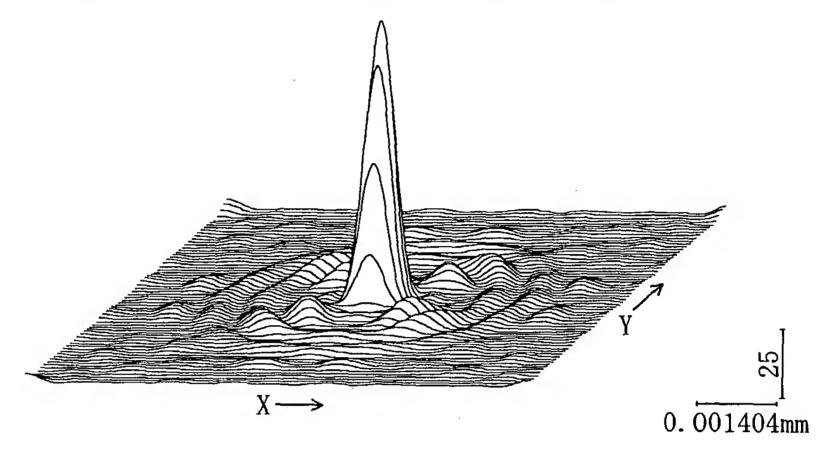


FIG. 11B

Design example 1: Point image intensity distribution in CD (Numerical aperture not limited)

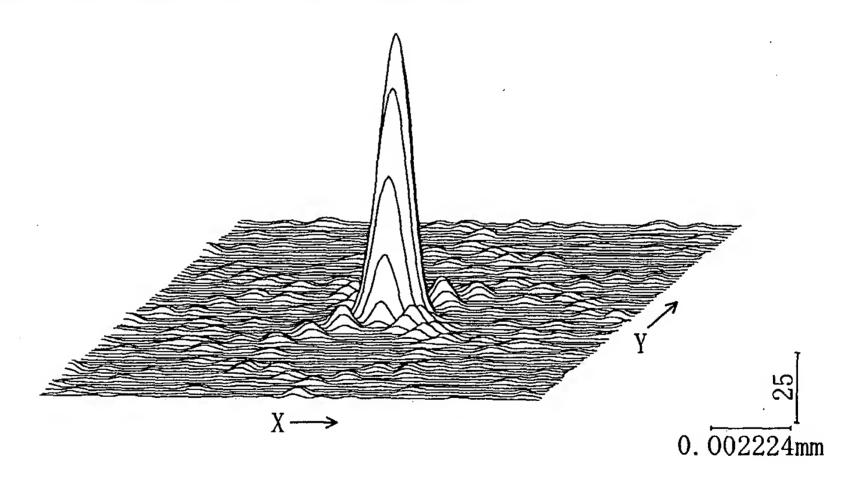


FIG. 11C

Comparative design example:
Point image intensity distribution in CD
(Numerical aperture not limited)

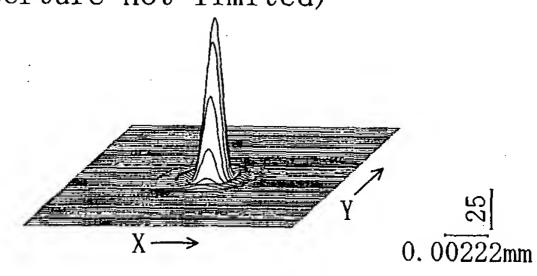


FIG. 12A

Design example 2: Point image intensity distribution in DVD

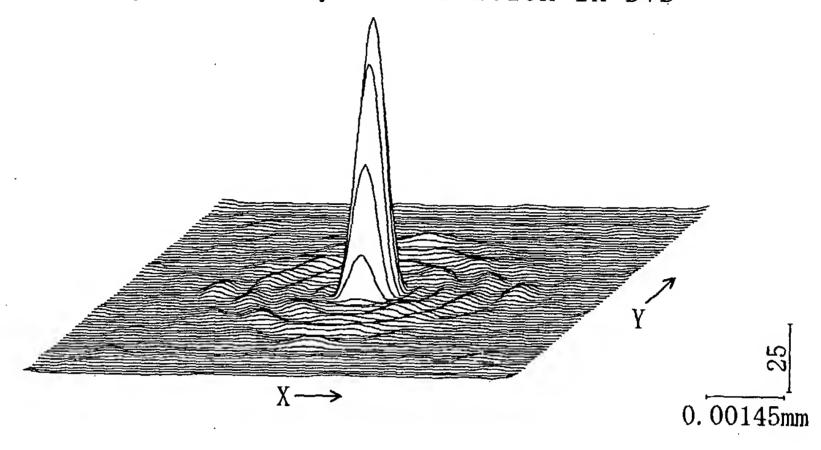


FIG. 12B

Design example 2: Point image intensity distribution in CD (Numerical aperture not limited)

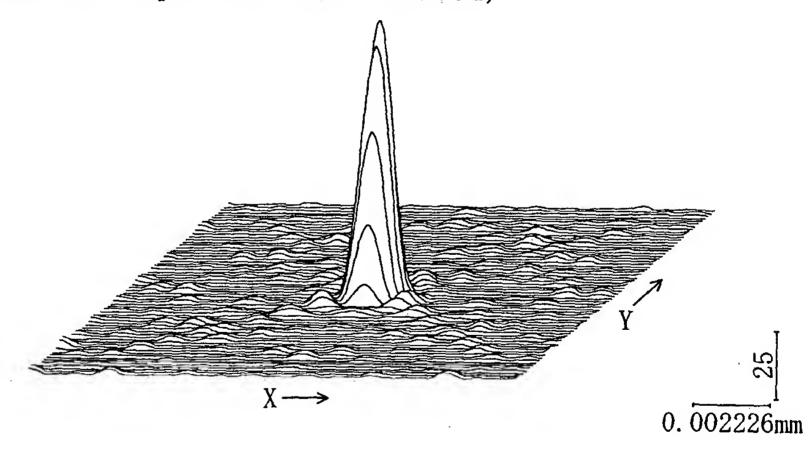


FIG. 12C

Comparative design example:
Point image intensity distribution in CD
(Numerical aperture not limited)

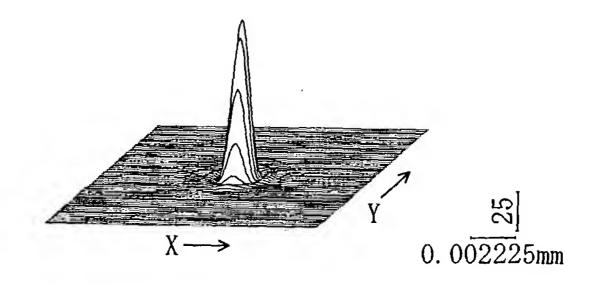


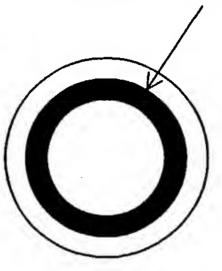
FIG 13

| | S | Spot diameter (μ m) | (m m) | Spot diameter | neter(μ m) | | Side robe(%) | (%) |
|------------------|-------|-----------------------------------|--------|------------------|-------------------------------|-------|--------------|-------------------------------|
| | Nu | Numerical aperture not limited | ture | Numerical lim | Numerical aperture limited | | | |
| | DAD | CDX | CDY | CDX | CDY | DVD | CD | CD Numerical aperture limited |
| Design example 1 | 0.897 | 1.406 | 1. 437 | 1.455 | 1.450 | 3. 25 | 3.17 | 1.86 |
| Design example 2 | 0.912 | 1. 445 | 1. 448 | 1. 441 | 1. 449 | 2.23 | 2.36 | 2.06 |

FIG. 14A

FIG. 14B

Masking for lens for DVD (shielding portion) Masking for lens for CD (shielding portion)



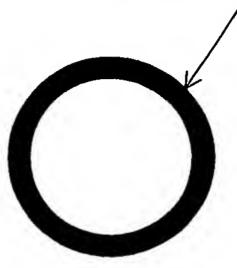


FIG. 14C

| · | | Wave aberration (λRMS) | Spot diameter (μm) | Side robe (%) |
|------|--------------|------------------------------|--------------------------|------------------|
| DIID | With mask | 0.0172 | 0.89×0.89 | 2. 47 |
| DVD | Without mask | 0. 3325 | 0.89×0.89 | 2. 30 |
| | With mask | 0.0066 | 1.45×1.45 | 1. 79 |
| CD | Without mask | 1. 5278 | 1.44×1.45 | 1. 79 |

FIG. 14D

| | | Wave aberration (λRMS) | Spot diameter (μm) | Side robe (%) |
|-----|--------------|------------------------------|--------------------------|------------------|
| | With mask | 0. 0238 | 0.90×0.90 | 1.37 |
| DVD | Without mask | 0. 1941 | 0.91×0.91 | 1. 37 |
| | With mask | 0. 0265 | 1.46×1.47 | 2. 12 |
| CD | Without mask | 1. 3776 | 1. 43×1. 40 | 2.05 |

FIG. 15

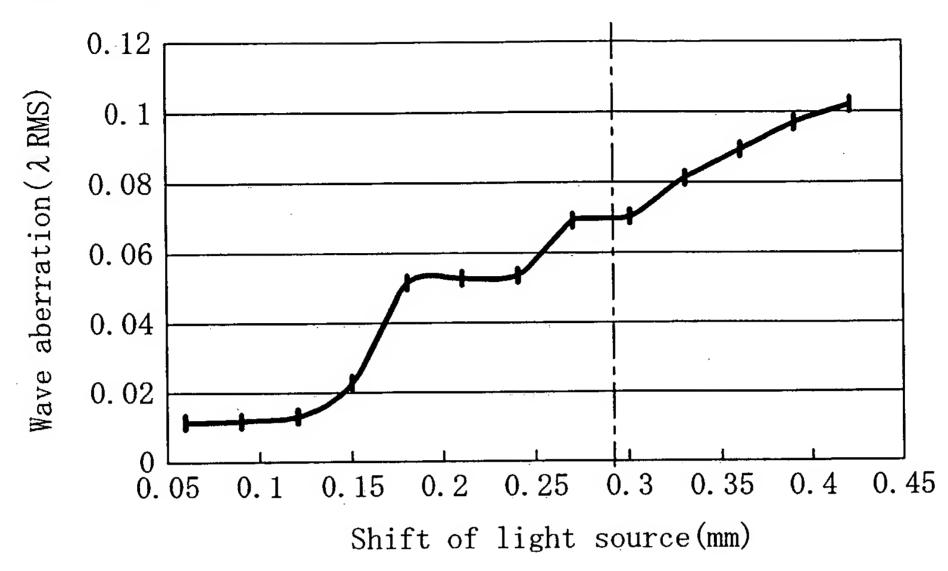


FIG. 16A
PRIOR ART

Sti Sd2 Sd3

First optical disk

First focusing position

Center

Second ocusing position

FIG. 16B
PRIOR ART

Sd3

Sd2

Sd3

Sd2

Sd3

Sd2

Sd1

n-type GaAs current blocking layer , n-type AlGaInP cladding layer p-type AlGaInP cladding layer n-type GaAs buffer layer n-type GaAs substrate AlGaInP-based semiconductor laser -p-side electrode Activation layer 102 p-type GaAs capping layer n-side electrode p-type GaInP intermediate layer electrode p-side p-type GaAs capping layer laser n-type GaAs buffer layer semiconductor AlGaAs-based FIG. 17 layer n-type AlGaAs cladding PRIOR ART)-type AlGaAs cladding layer 9 Activation layer 1-type GaAs current blocking layer

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